4-20-2018

Agriculture Engine Oil Filter Test Stand

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Problem Statement
Our group worked on a project from Fleenor Manufacturing. This is a small company based out of Pella, Iowa owned by Jeff Fleenor. Jeff's company focuses on creating solutions to unique problems across a wide spectrum of markets (Bruning et al., 2017; Yeggy et al., 2017). On this project, our client wanted to improve an existing test stand used for running oil filter tests, which can take up to four hours per test, and only test one filter size. We would like to minimize the time it takes to run a test while also enabling it to use different filters. Other companies are considering this technology because it can show them exactly how their products compare to others on the market. The completion of this project could help our client understand how OEM filters differ from aftermarket filters and how our client's own design compares to all the other filters on the market.

Disciplines
Bioresource and Agricultural Engineering | Industrial Technology

IOWA STATE UNIVERSITY

Department of Agricultural and Biosystems Engineering (ABE)

TSM 416 Technology Capstone Project

Agriculture Engine Oil Filter Test Stand

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Contact(s): Jeff Fleenor, Owner/Operator, fleenormfg@lisco.com; Anthony Lo, aslo@alumni.iastate.edu

1 PROBLEM STATEMENT

Problem Statement

- Our group worked on a project from Fleenor Manufacturing. This is a small company based out of Pella, Iowa owned by Jeff Fleenor. Jeff's company focuses on creating solutions to unique problems across a wide spectrum of markets (Bruning et al., 2017; Yeggy et al., 2017).
- On this project, our client wanted to improve an existing test stand used for running oil filter tests, which can take up to four hours per test, and only test one filter size.
- We would like to minimize the time it takes to run a test while also enabling it to use different filters.
- Other companies are considering this technology because it can show them exactly how their products compare to others on the market. The completion of this project could help our client understand how OEM filters differ from aftermarket filters and how our client's own design compares to all the other filters on the market.

Business Case Statement

A. **What is wrong**: The cleaning circuit speed and the inability to run more than one type of filter on the test stand.

B. How extensive: Our problem could be extensive because an adapter plate will need to be created to solve our inability to test more than one filter. Our problem with the cleaning time is complicated by the variance of the test stand from test to test

C. **When and where do the problems occur:** The problems occur in the cleaning circuit of our test stand and in the test filter housing of our test stand.

D. **Why address this problem**: Our client needs to be able to compare different brands and sizes of filters at a faster pace, which the current test stand cannot do.

E. Who cares about the problem: The companies of whom are selling, using, buying, and or creating engine oil filters would have a use for this problem to be fixed as it would allow our client to compare different filters side by side and publish data of his results.

2 GOAL STATEMENT

- **Main Objective(s) and Specific Objectives**
    - **The main objective:** Our group helped solve the problem of slow test times and the inability to use different types of filters on the test stand. To do this we improved the time it takes to clean the oil before and after the test is complete. Also, implementing an adapter plate to adjust to different types of filters for the test stand.
    - **Specific objectives include***:*
        - Find a solution for an adapter to test multiple filters that satisfies client's needs.
            - Fits multiple size filters
            - Ability to be removed and installed easily
            - Must fit directly to the current test stand
        - Design a more efficient test circuit that satisfies clients' needs.
            - Cut the cleaning time down around 50%
            - Be simple and effective
            - Must be done without designing a new test stand
- **Rationale**
    - Gain the ability to test multiple filter types with simplicity and efficiency.
    - Reduce cleaning time by at least 50% so multiple tests can be performed a day.
    - Create a test stand that will allow our client to gain knowledge and data and eventually publish the results of his tests.

3 PROJECT PLAN/OUTLINE

A. Methods/Approach

- **Reference Materials**
    - We used a Fluid Power Lightning Reference Handbook (Fluid Power, 1990), so we could quickly find solutions to any fluid power problems, and the book *Fluid Power with Applications* (Esposito, 2009).
    - We also used Part Descriptions and Cross Reference Manuals to help collect our data.
- **Data collection**
    - Data for our project includes the specifications of the filters across different areas of use that are selected to be tested i.e. (Semis, Tractors, Pickup trucks).
    - Data also includes particle counts from various tests run directly from the test stand.

- **Skills**
    - We used knowledge gained from our, TSM 337 (Fluid power) and TSM 240 (Manufacturing Processes) classes to complete this project and learn more about the filters and the system we looked at.
- **Solutions:**
    - As a group, we sat down with our client and went over different solutions for our two main problems.
    - To solve our slow cleaning time problem, we originally decided to try and bypass the cleaning circuit:
        - By doing this we would only add particles back to the tank without running the cleaning circuit at all.
        - This was a very cost-effective idea as it did not involve any extra money into the test stand.
        - This idea proved to be very difficult as the current test stand has too much variance for this idea to be reliable.
    - We essentially scraped that idea and went with our second solution which was adding more filters in series to our cleaning circuit:
        - This solution was simple and reliable
        - This solution did cost $490 to implement for only the parts
        - This solution has cut cleaning and warm up times by about %50
    - To solve the problem of only being able to run one filter, everyone agreed an adapter plate would work best:
        - Our client already had a very detailed drawing of an adapter plate
        - Our group decided to use his drawing and have the plate made through B&K Machining out of Pella, Iowa, with a cost of $281.25
        - This allowed our group for more time in the early stages of our attempt to bypass the cleaning circuit
        - The adapter plate works as it should with no leaks and a minimum amount of flaws

- **Organization**
    - Our Team communicated with our client on a bi-weekly basis and met with our client monthly.
    - As a group, we split up to complete major milestones with ease.
    - The Major Milestones for our project include:
        - Design a faster cleaning circuit.
        - Deciding that the proposed cleaning circuit solution would not work as planned
        - Implementing the proposed solution that was known to work for the cleaning process.
        - Implementing an adapter plate that fits our selected filters.
        - Testing and verifying that the cleaning circuit is faster and that the adapter plates work effectively.
    - In this project, we did have one major setback. We spent too much time trying to make our original proposed solution for the cleaning circuit work. When we

realized that our solution would not work, we were almost out of time to complete the next proposed solution for the cleaning circuit problem.

B. Results/Deliverables

- The main two deliverables in this project were to design and implement a faster cleaning circuit and an adapter plate that allows for a wider variety of filters to be tested.
- The two deliverables were succeeded, as we have decreased the time it takes to clean and warm up the circuit by 50% and we have also implemented an adapter plate to allow for multiple other filters to be tested.
- We did have some time to run some real tests on other filters, which was not included in the scope of the project. Running these tests will help our client continue to move closer to his goal of understanding how magnetic array filtration works on oil filters across multiple areas of interest.
- There are results from some of the Test we ran in Appendix B, and they show that the MAF filter improves the cleanliness of the oil. These tests also prove that the adapter plate works as designed, as we had to use the adapter plate for the tests that were run, and the data looks like previous tests that were run off of the original test stand.
- Our recommendations for improving the test stand in the future include:
    1. Design and fabricate a tank that improves particle suspension.
    2. Work on a better method of particle insertion.
    3. Replace hoses with metal piping to reduce particles being caught in the circuit.
    4. Eventually, the best option would be to design a test stand that is better designed to handle more than one type of filter and test at a faster pace.

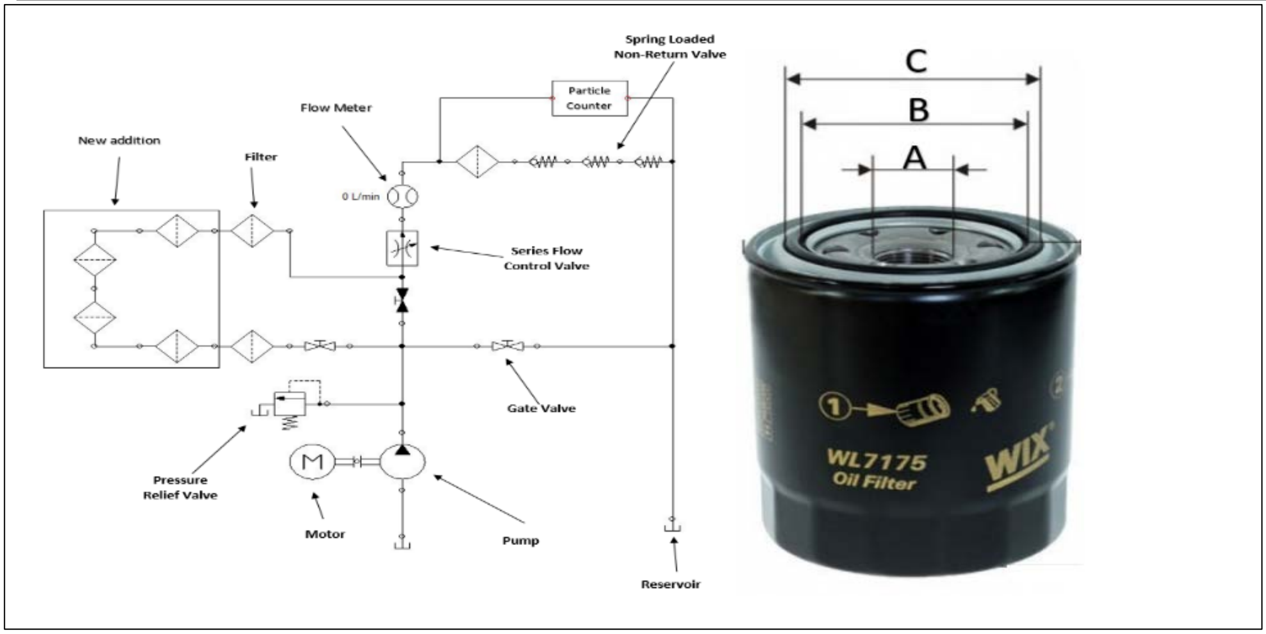
4 BROADER OPPORTUNITY STATEMENT

When looking at this project at first glance it seems this may only affect the fluid power industry. However, when looking at the big picture this project has the potential to affect the automotive industry and any industry which uses heavy machinery. Our project not only focused on improving the current test stand but also focused on testing a new filter which has the potential to reduce particles getting through the filter and going through the circuit. When these particles enter a hydraulic system, they hit surfaces repeatedly and after so long they cause damage to the system from wear and tear. By testing this new filter in comparison to current day filters we can see if we are able to lower the number of particles which get through current filters. If data shows our product does indeed lower particle count we have the potential to increase the life of many fluid power circuits in the industry today which includes: car, truck, and tractor motor life. Potentially this project can revolutionize the fluid power industry and potentially even the automotive industry as well.

5 PROJECT SCOPE

Our project, Agricultural Engine Oil Filter Test Stand, our focus was on bettering the current test stand that is used to compare MAF (magnetic array filtration). Bettering the test stand includes, solving the inefficient warm up and cleaning cycles and creating and implementing a way to test multiple different sized filters on the current test stand. For the Agriculture Engine Oil Filter Test Stand project, we will focus on everything from filter research, finding adapter solutions for filters to creating and testing a more efficient filter testing system to benefit our customer, Fleenor MFG. Our focus will be on these three goals for much of the project.

6 Graphical Abstract



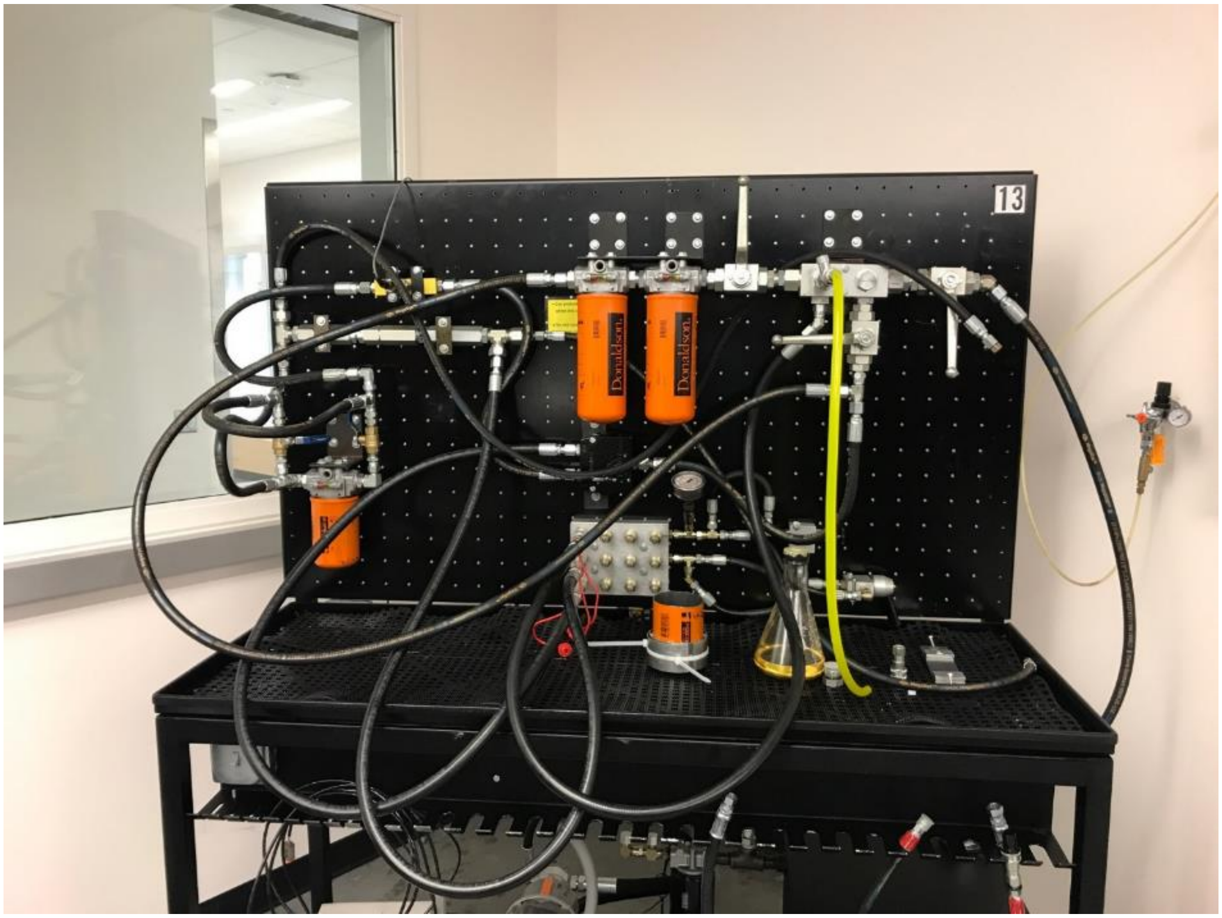
7 References

- Kevin Bruning, Robert Millhuff, Adam Prybil, Austin Thomas, Joseph F. Vanstrom, and Jacek A. Koziel. Benchtop Mounting System. Final Report. TSM 416 Technology Capstone Project, April 28, 2017.
- Esposito, Anthony. Fluid Power with Applications. Pearson Prentice Hall, 2009.
- Fluid Power Designers' Lightning Reference Handbook. Paul-Munroe Hydraulics, 1990.
- Bret Yeggy, Cody Allen, Rob Davis, Chad Dolphin, Joseph R. Vanstrom and Jacek A. Koziel. Modular Hydraulic Test Bench. Final Report. TSM 416 Technology Capstone Project, April 28, 2017.

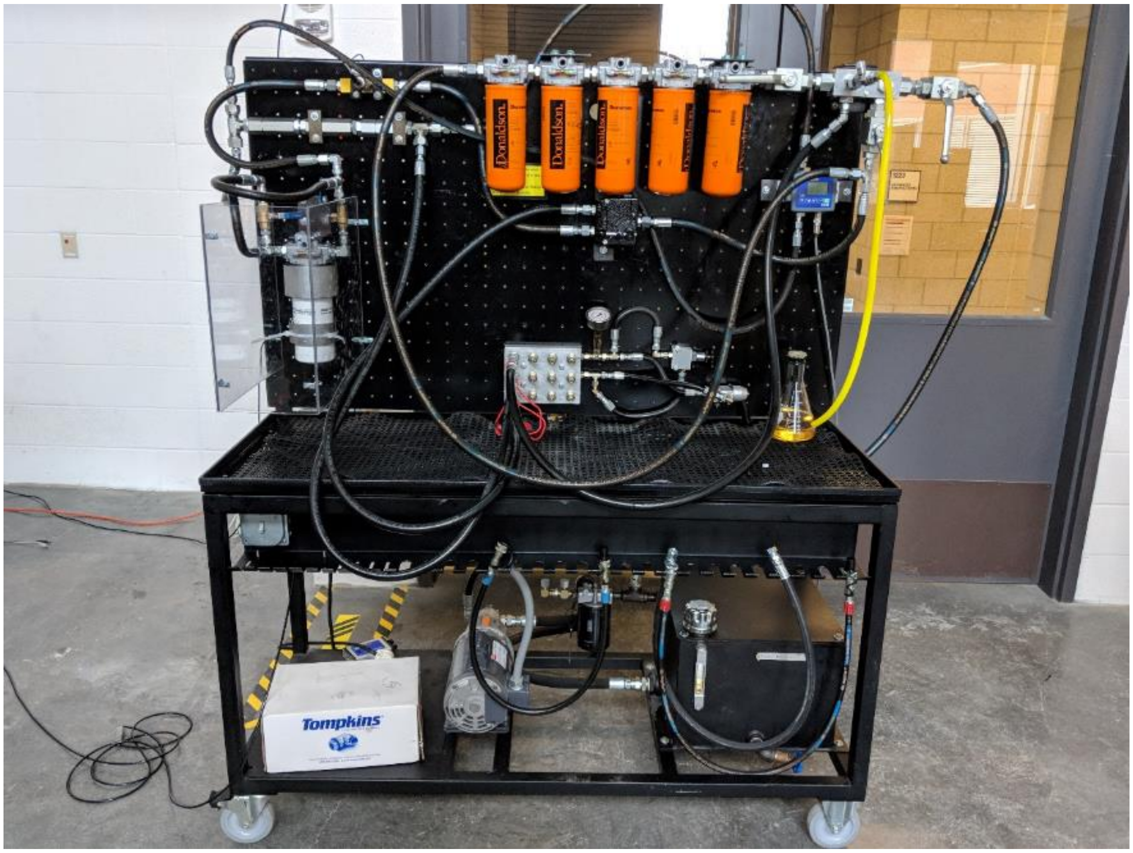
8 Appendixes

Appendix A

Department of Agricultural and Biosystems Engineering (abe@iastate.edu) aims to be a premier team serving society through engineering and technology for agriculture, industry and living systems. ABE welcomes opportunities to discover and improve new technologies for all stakeholders.

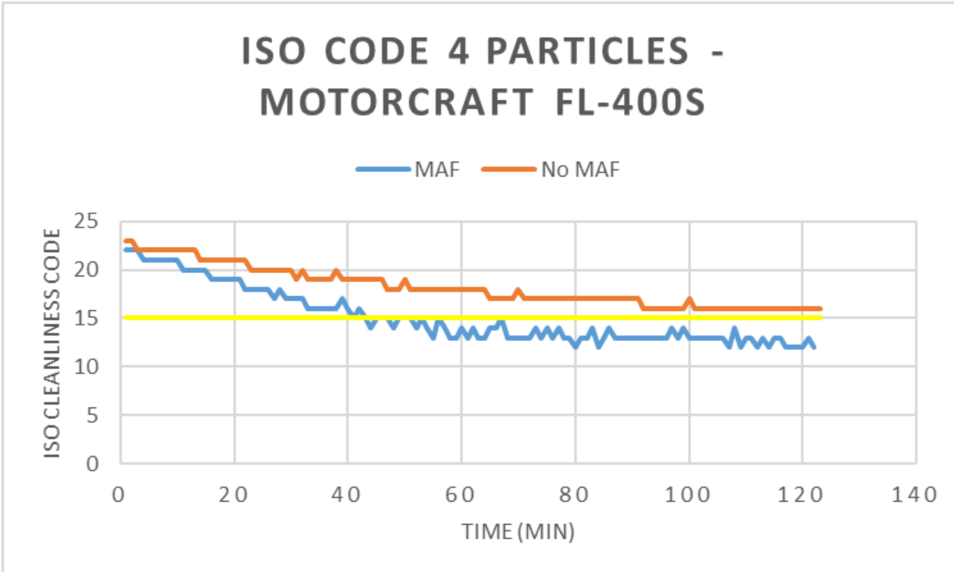


This is what the test stand looked like when we started our project.

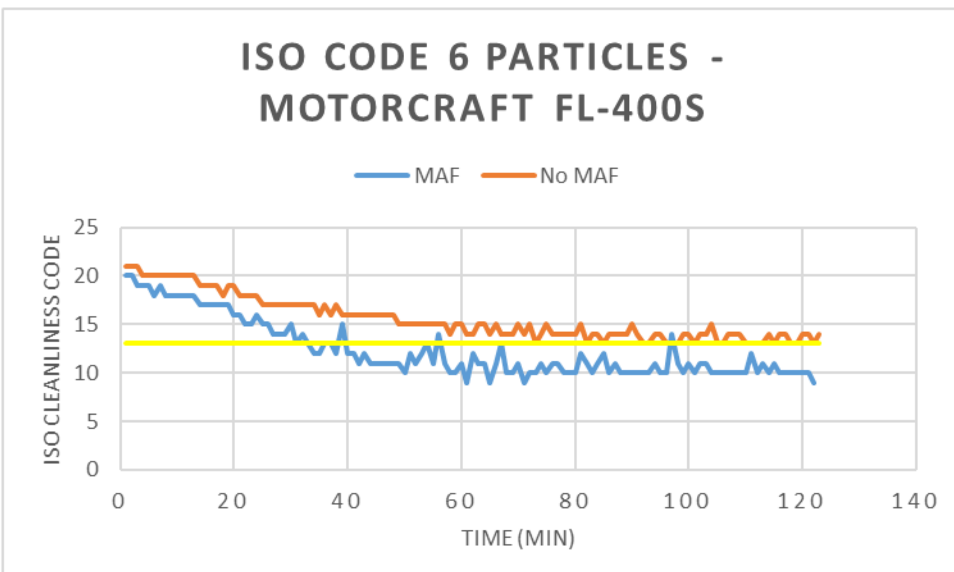


This is what the test stand looks like today after the project was completed.

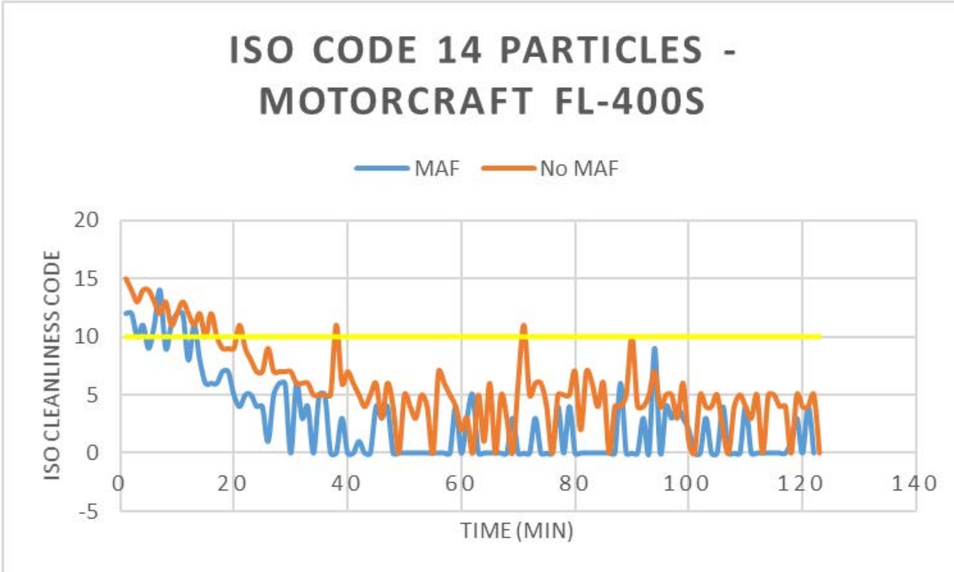
Appendix B



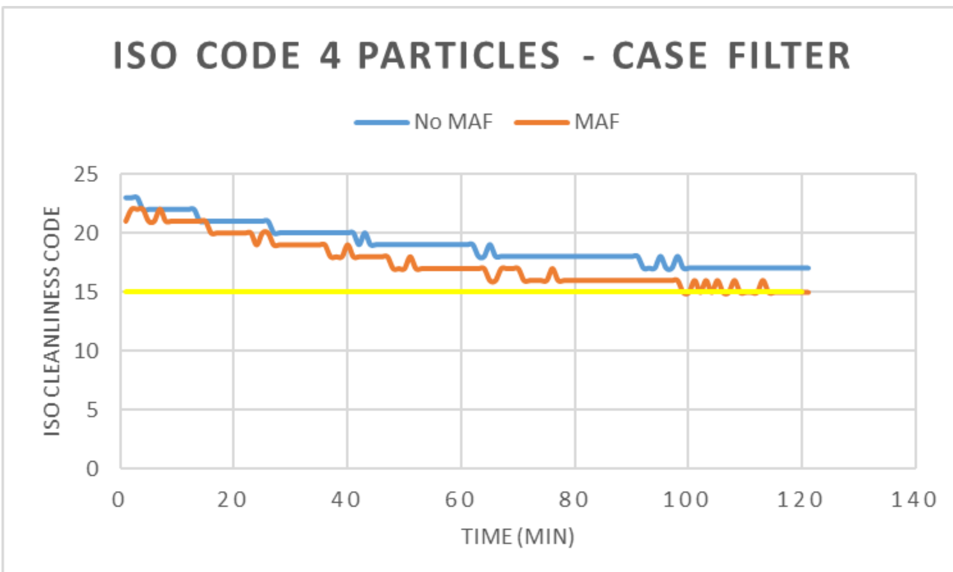
A graph of actual data that was pulled after our project was completed. This graph, is looking at ISO code 4 sized particles. The yellow line represents the cleanliness code needed for a servo-valve. In these tests we were looking at a Motorcraft filter that was designed for small ford cars and trucks.



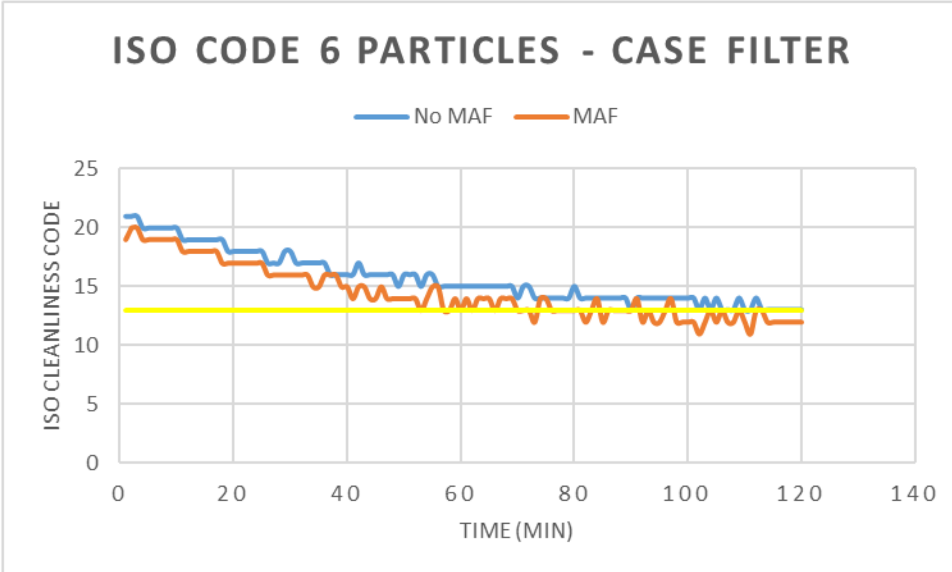
Another graph looking at the same test with ISO code 6 sized particles, the yellow line still represents the required ISO code for a servo-valve.



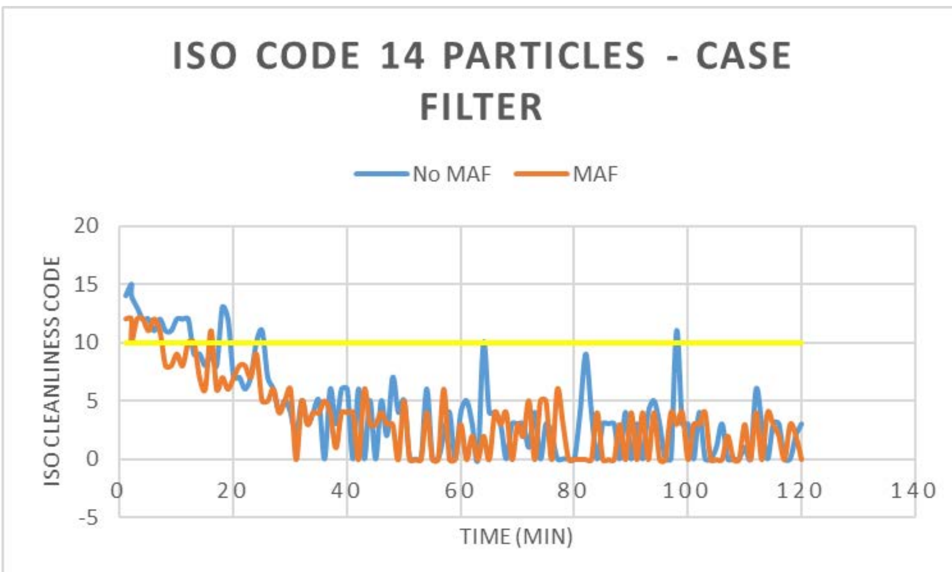
Another graph looking at the same test with ISO code 14 sized particles, the yellow line still represents the required ISO code for a servo-valve.



A graph of actual data that was pulled after our project was completed. This graph, is looking at ISO code 4 sized particles. The yellow line represents the cleanliness code needed for a servo-valve. In this case we were testing a Case IH brand filter which was meant for a medium sized tractor.

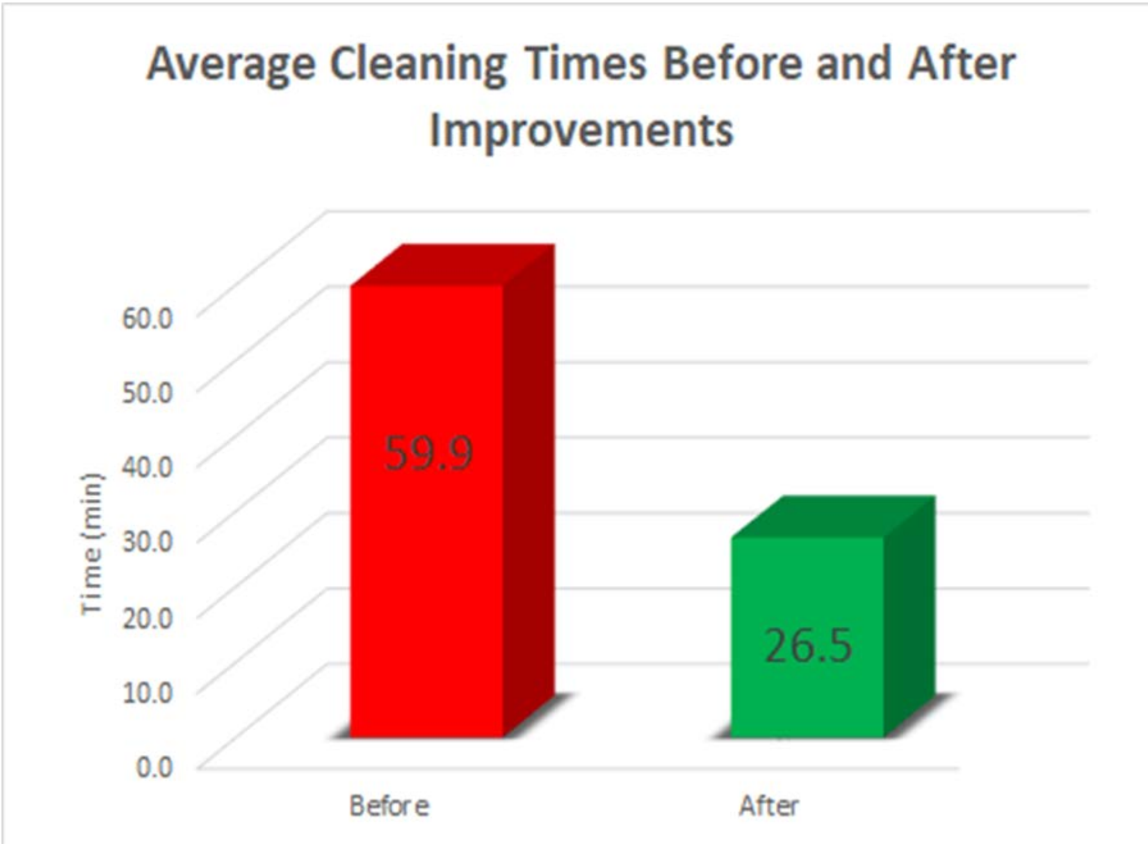


Another graph looking at the same test with ISO code 6 sized particles, the yellow line still represents the required ISO code for a servo-valve.



Another graph looking at the same test with ISO code 14 sized particles, the yellow line still represents the required ISO code for a servo-valve.

Appendix C



This graph represents the cleaning circuit time before and after our improvements to the cleaning circuit. As you can see in this graph we cut the cleaning circuit times in half which was our original goal.